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RELMO USER'S GUIDE

Version 1.0

RELATIVE MOTION BETWEEN SHIPS IN RANDOM SEAS

by

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PREFACE

The purpose of this report is to present technical information. The information contained in this report is technical in nature. It does not represent the policy of the Naval Civil Engineering Laboratory, the Naval Facilities Engineering Command, the Assistant Commander of Engineering and Design, or the Director of Engineering System Division. It is one of a series designed to provide technical information and documentation for studies conducted in support of the Naval Facilities Engineering Command Graphics Engineering and Mapping System, Engineering Microcomputer Graphics, Computer-Aided Design, Cost Engineering System, and Guide Specifications System as they relate to the Naval Facilities System and life cycle facilities management.

CONTENTS

INTRODUCTION

RELMO is a computer program written to calculate the relative motion between moored and unmoored vessels in shoal water. Moored, in the context of this usage, implies the vessel is only restrained in the surge direction. The mooring forces are assumed to be linear.

CAPABILITIES

RELMO includes the following features:

- The wave spectrum used to describe the incident waves can be either the Pierson-Moskowitz or the Bretschneider spectrum.
- The incident waves may approach from any direction relative to the stern of the first vessel.
- The vessel is assumed stationary, that is, it is not underway.
- The dynamic response operators for both ships can be saved in a file which can be used as input to another program.
- The relative motion quantities do not have to be computed, so the program can be used to study the motion of a single vessel.
- RELMO uses strip theory, which is applicable to long narrow vessels typically with length-to-beam ratios greater than 8. Reference 1 showed how the results of strip theory diverged from test results and three-dimensional diffraction theory results for barges with length-to-beam ratios less than 8. However, Reference 2 found that the results of strip theory compared adequately well with test results for barges with length-to-beam ratios between 2.5 and 4.0. In light of this conflict and the fact that strip theory is theoretically designed for long narrow ships, this program should be used with care. For more information on diffraction theory see Reference 3.

SOLUTION METHODS

RELMO uses strip theory to compute the displacement response amplitude operators (RAO) for the vessels as discussed in References 4 and 5. The RAO is computed for a point located at the center of

gravity of the vessel. A transformation is included to move the RAO to any location in space. The Pierson-Moskowitz spectrum or Bretschneider two-parameter spectrum is used to describe the behavior of the sea. The displacement autospectra functions are computed by multiplying the respective displacement RAO times the appropriate sea spectrum. The displacement autospectra are converted to velocity and acceleration by multiplying the displacement ordinate by the frequency or frequency squared, respectively. The area under these spectra is the variance of the respective time history assuming a zero mean velocity time history. The relative motion operators for ship 2 with respect to ship 1 are computed. Finally, the relative motion is statistically determined using the variance of the respective spectra. The statistical information showing the displacement motion for each vessel is also computed. The statistical information that is presented describes the 2 percent (twice the standard deviation) chance that the value presented will be exceeded. It is assumed that the user is familiar with these concepts, which are common in computing motion of ships.

PROBLEM DATA PREPARATION INSTRUCTIONS

Data are entered on four types of input lines: WAVE, SHIP, RELATIVE, and identification.

Line Type A: problem identification.

Variable	Columns	Description
NAMPRB	1-80	Identify the problem, taking care to uniquely describe each problem to clearly distinguish the results.

Line Type B: WAVE description.

These lines are used to define the period, length, and direction of the unit amplitude incident waves. Regular waves as opposed to random waves are used to obtain the dynamic response operators. The required information includes:

Variable	Columns	Description
DEPTH	1-10	The mean water depth, in feet, at a station beneath the center of gravity of Ship 1. The datum plane is located at the sea-air interface.
BETAD	11-20	The angle (degrees) of approach of the incident unit amplitude waves. BETAD = 0 indicates that the waves approach from the direction of the stern. BETAD propagates in the counterclockwise direction.
FREMAX	21-30	The maximum angular wave frequency (RAD/SEC).

FREMIN	31-40	The minimum angular wave frequency (RAD/SEC). Intermediate wave frequencies, totalling NFREQ-2 in number, will be spaced equally between the extremes defined by FREMIN and FREMAX.
NFREQ	41-50	The number of angular frequencies to be used in computing the ship dynamic response operators. This variable and the one for the number of ship transverse sections (NSEC) have a predominant effect on the amount of computation time required. The increase will be roughly the product of NFREQ and NSEC. NFREQ should be at least 50 to insure sufficient accuracy in most ship motion problems.
ISTOP	51-60	For any integer value other than zero, a new set of data lines beginning with the problem identification line are read. This feature permits a series of problems to be studied. The default is ISTOP = 0.
IOPER	61-70	Dynamic response operators are calculated when IOPER = 1, otherwise both the dynamic response operators and the relative motion quantities are calculated when IOPER = 0. The default is IOPER = 0.

Line Type C: SHIP identification.

Variable	Columns	Description
ISHIP	1-10	Shows by the integers 1 or 2 whether the data following is for Ship 1 or 2. The larger of the two ships is usually Ship 1. If only one ship is involved in a set of calculations, it should be labeled Ship 1.
NAMSHP	21-80	Record the ship name.

Line Types D, E, and F: SHIP description.

These lines define the characteristics of the ship identified by the previous line. Each of the two ships being modeled require a ship identification line and a set of ship description lines. The following is required for each ship:

Line Type D:

Variable	Columns	Description
BG	1-10	The vertical separation in feet between the ship center of gravity (CG) and center of buoyancy (CB). BG is positive if the CG lies above the CB.
XCGFS	11-20	The longitudinal distance in feet of the ship CG measured from the aft perpendicular.
GMT	21-30	Transverse metacentric height in feet.
OG	31-40	The vertical distance in feet between the ship CG and the water plane. OG is positive if the CG lies above the water plane.
RG	41-50	The radius of gyration of the ship in pitch. If unknown, RG may be set equal to 1/4 of the ship length.
RGZ	51-60	The radius of gyration of the vessel in yaw. This can be set to the radius of gyration in pitch if unknown.
W	61-70	The weight or displacement of the ship in pounds.

Line Type E:

Variable	Columns	Description
ZETA	1-10	The roll damping coefficient. Use ZETA = 0 for round hull vessels and ZETA = 0.08 for vessels with flat bottom hulls.
TPHI	11-20	The vessel natural roll period in seconds. If unknown, the roll period can be estimated from the following expression: TPHI = C*B/SQRT(GMT) where C is an empirical constant varying from 0.44 for full formed merchant ships to 0.39 for more round hull ships.
KX	21-30	The effective surge mooring spring constant in units of LB/FT, assumed to be 0.0 if not entered on ship card.
NSEC	31-40	The number of transverse ship sections. There can be as few as 1. The usual value is 10 or 20.

KXOVER	41-50	If only one spring constant is used in a problem, set KXOVER equal to one. This is the default value. When KXOVER equals two, more ship lines having different KX values will be read. For a given ship and for constant wave conditions, this option allows the computation of ship response for a range of KX values without having to recompute added-mass and damping coefficients.
NOMORE	51-60	Motion for a single vessel will be computed if this variable is set equal to zero. Setting NOMORE, on the first ship line, equal to any positive integer causes the computer to read a ship line for a second vessel and to compute the relative motion between both vessels. NOMORE must be set equal to zero on the second ship line.

Line Type F:

Variable	Columns	Description
B(1)	1-10	The ship's beam in feet measured at the water line for each transverse section.
DRAFT(1)	11-20	The vertical distance in feet from the water line to the keel at each transverse section.
SECL(1)	21-30	The thickness in feet of each transverse section SECL is usually the same for all sections.
SECOE(1)	31-40	The ship section coefficient at each transverse section. Bulbous sections will have coefficients greater than unity. Grims method for computing the section added-mass and damping will provide poor estimates if SECOE greatly exceeds 1.
ZCBM(1)	41-50	The vertical distance in feet between the keel and the center of buoyancy at each transverse section.

Line Types G, H and I: RELATIVE motion.

These lines contain data pertaining to ship coordinates and the characterization of the incident random sea employed in the relative motion model. Omit these lines if IOPER = 1.

Line Type G:

Variable	Columns	Description
		Ship 1
XF(1)	1-10	The longitudinal ship coordinate of interest. The origin of the coordinate is at the aft perpendicular of the ship. If necessary, XF can extend beyond the bow or stern of the ship.
YR(1)	11-20	The transverse ship coordinate of interest, and like HCG, its origin is at the vessel's CG.
HCG(1)	21-30	The vertical ship coordinate of interest. For each ship, HCG is measured from the vertical center of gravity.
		Ship 2
XF(2)	1-10	The longitudinal ship coordinate of interest. The origin of the coordinate is at the aft perpendicular of the ship. If necessary, XF can extend beyond the bow or stern of the ship.
YR(2)	11-20	The transverse ship coordinate of interest, and like HCG, its origin is at the vessel's CG.
HCG(2)	21-30	The vertical ship coordinate of interest. For each ship, HCG is measured from the vertical center of gravity.

Line Type H:

Variable	Columns	Description
XS21	1-10	The longitudinal distance in feet separating the aft perpendicular of Ship 2 from the aft perpendicular of Ship 1.
YCG	11-20	The transverse distance in feet separating the CG of Ship 1 from the CG of Ship 2. For problems with a single vessel YCG = 0.0.
	21-30	Not used, leave blank.
WWPSD	31-40	Variable used to select the form of the incident wave spectrum. WWPSD = 0 — Pierson-Moskowitz spectrum is used (default). WWPSD = 1 — Bretschneider spectrum is used.

NSEA	41-50	This integer variable designates the number of random seas defined by the Pierson-Moskowitz or Bretschneider power density spectrum.
MORSEA	51-60	The computer will not print out the relative motion response amplitude operators if MORSEA is greater than 0, the default is 0.
MORREL	61-70	The computer will read an additional RELTIV line for MORREL greater than 0. The last RELTIV line must state that MORREL = 0.
IPSD	71-80	The power spectral density function (PSD) and significant values computed from the PSD will be printed for each degree of freedom if:

IPSD = 0	No PSD output (default)
IPSD = 1	PSD for absolute motion for Ship 1 only
IPSD = 2	PDS for absolute motion for both ships
IPSD = 3	PSD for relative motion between Ships 1 and 2

Line Type I: SEA description.

Variable	Columns	Description
SEA(1)	1-10	Defines the value of each significant wave height, $H_{1/3}$, to be used in computing the wave height power density spectrum. The number of SEA values listed correspond to the integer listed under NSEA.
T13(1)	11-20	Defines the value of the significant period associated with SEA(1) to be used in the Bretschneider two-parameter power density spectrum.

EXECUTION INSTRUCTIONS

The program is designed to run on an IBM PC compatible personal computer having at least 512K memory and a math coprocessor. An ancillary program for plotting RAOs and PSDs also requires, if this program is used, an enhanced graphics adaptor (EGA) or a size A plotter that is compatible with the Hewlett Packard 7475A plotter. There are a number of ways to execute these programs, and each will be discussed.

Installation

The RELMO program is on a single diskette. The diskette contains:

RELMO.EXE	The executable program
TEST.DAT	The example problem in the appendix
RUNRELMO.BAT	The batch execute file for RELMO
RELMOPLT.EXE	The RAO plotting program
RUNRPLT.BAT	The batch execute file for RELMOPLT
RMFORT.ERR	The execution error message file

These files should be copied to the hard disk or to another floppy disk before the program is used. The standard DOS COPY Command can be used:

```
COPY A:*.* C:   For the hard disk
COPY A:*.* B:   For the floppy disk
```

The program is now ready to run using one of the methods described below. A second diskette containing a library of ship and barge input data may be requested.

Standard Execution

The standard way of executing the program involves preparing an input file and running the program with the print output going to a file and the RAO output going to a second file which later can be plotted. A third output file, which can also be used for plotting, contains the PSD values selected by the IPSD variable. The program assumes the input data is contained in the file RELMO.DAT. The data can be prepared using any line or screen editor program, such as the DOS EDLIN editor. The user should prepare this file using the RELMO.DAT file name, or the input can be prepared using any file name, then copying the prepared file to RELMO.DAT by using the standard DOS COPY Command. The program will write the output to RELMO.OUT and it will write the RAO data to the RELMO.RAO file and the PSD data to the RELMO.PSD file. The RELMO.OUT file can be printed using the standard DOS PRINT Command. The other two files can be used for plot post-processing.

The program RELMO.EXE is executed by typing:

```
RELMO
```

Before plotting RAO or PSD data the first time, issue the following DOS command to make sure the plotter communications mode has been correctly specified:

```
MOD COM1:9600,N,8,1,P
```

The program RELMOPLT.EXE can now be executed using the command:

```
RELMOPLT
```

Output Redirection

The user can use the DOS SET Command to redirect the input and output. The default input, output, and plot file names can be changed by:

```
SET RELMO.DAT= your input file name
SET RELMO.OUT= your output file name
SET RELMO.RAO= your RAO output file name
SET RELMO.PSD= your PSD output file name
```

Then the program can be run by the RELMO command and plotting can be done by the RELMOPLT command. CAUTION! The DOS redirection mechanism is active for the duration of the run of the program. The SET Command stays set until the connection is broken in the following manner or through a system reboot:

```
SET RELMO.DAT=
SET RELMO.OUT=
SET RELMO.RAO=
SET RELMO.PSD=
```

Batch File Execution

The programs can be run with a batch file. For example, the batch file might be called RUNRELMO.BAT, and it would contain:

```
SET RELMO.DAT=%1.DAT
SET RELMO.OUT=LPT1
SET RELMO.RAO=%1.RAD
SET RELMO.PSD=%1.PSD
RELMO
RELMOPLT
SET RELMO.DAT=
SET RELMO.OUT=
SET RELMO.RAO=
SET RELMO.PSD=
```

The program would then be executed by the command:

```
RUNRELMO <your data file name without its assumed DAT
extension>
```

REFERENCES

1. Civil Engineering Laboratory. Memorandum to files on the prediction of ocean platform response, by H.J. Migliore and P.A. Palo. Port Hueneme, CA, Jan 1979.

2. ____________. Memorandum to files on the applicability of strip and diffraction theory models as determined from the Noble Denton comparisons, by Paul A. Palo. Port Hueneme, CA, Mar 1981.

3. Naval Postgraduate School. NPS-69 Gm 77091: Hydrodynamic interaction of waves with a large displacement floating body, by C.J. Garrison. Monterey, CA, Sep 1977.

4. Naval Civil Engineering Laboratory. Technical Note N-1183: The relative motion between ships in random head seas, by D.A. Davis and H.S. Zwibel. Port Hueneme, CA, Sep 1971.

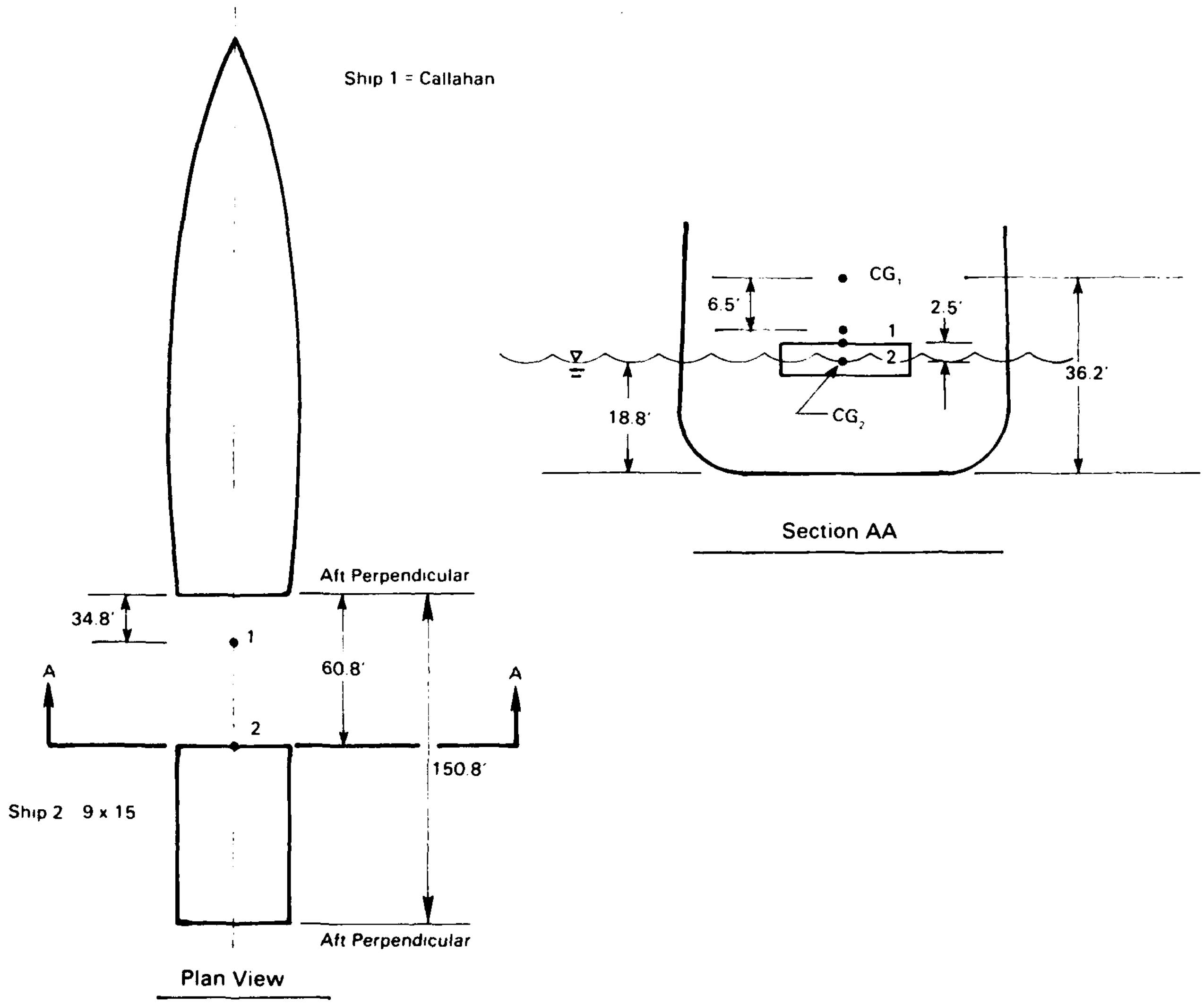
5. ____________. Technical Note N-1371: The motion of floating advanced base components in shoal water - a comparison between theory and field test data, by D.A. Davis and H.S. Zwibel. Port Hueneme, CA, Jan 1975.

Appendix A

EXAMPLE PROBLEM ONE

PROBLEM

Find the relative motion between points 1 and 2 located on two ships as shown. The Callaghan is a RO/RO ship with a stern unloading ramp. The 9X15 is a shallow draft Navy lighterage (NL) pontoon receiving platform. The points of interest represent the ramp hinge point aboard the Callaghan (point 1) and the ramp base support on the deck of the 9X15 (point 2).



Example Problem One Input File, RELMO.DAT.

LINE	COLUMN							
	1	2	3	4	5	6	7	8
TYPE	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890
A	RELMO EXAMPLE PROBLEM ONE							
B	60.000	135.000	3.000	0.100	50	0	0	
C	1		CALLAGHAN					
D	25.530	268.800	7.400	17.380	173.560	173.560	0.358E+08	
E	0.060	14.880	0.000	20	1	1		
F-1	27.300	1.700	33.000	0.808	0.900			
F-2	39.400	4.800	33.000	0.647	2.400			
F-3	58.700	11.400	33.000	0.556	5.700			
F-4	69.800	18.100	33.000	0.553	9.100			
F-5	77.100	21.700	33.000	0.610	10.900			
F-6	82.400	22.200	33.000	0.694	11.100			
F-7	86.500	21.700	33.000	0.768	10.900			
F-8	88.900	20.800	33.000	0.853	10.400			
F-9	89.800	20.000	33.000	0.910	10.000			
F-10	89.900	19.200	33.000	0.920	9.600			
F-11	88.600	18.400	33.000	0.907	9.200			
F-12	84.100	17.600	33.000	0.865	8.800			
F-13	76.300	16.800	33.000	0.817	8.400			
F-14	65.500	15.900	33.000	0.769	8.000			
F-15	52.200	15.100	33.000	0.727	7.600			
F-16	38.300	14.300	33.000	0.698	7.200			
F-17	25.700	13.500	33.000	0.708	6.800			
F-18	14.500	12.700	33.000	0.900	6.400			
F-19	9.600	11.900	33.000	1.048	6.000			
F-20	10.600	11.100	33.000	1.025	5.600			
C	2		9X15					
D	1.830	45.000	292.000	1.170	22.500	22.500	0.408E+06	
E	0.080	1.600	0.000	1	1	0		
F	63.000	1.330	90.000	1.000	0.670			
G-1	-34.800	0.000	-6.480					
G-2	90.000	0.000	2.500					
H	-150.800	0.000	0.000	0.000	5	0	0	
I-1	2.000	0.000						
I-2	3.000	0.000						
I-3	5.000	0.000						
I-4	7.000	0.000						
I-5	10.000	0.000						

Example Problem One Output File, RELMO.OUT.

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RELMO EXAMPLE PROBLEM ONE

MEAN WATER DEPTH	60.00 FEET
NUMBER OF ANGULAR FREQUENCIES TO OBTAIN OPERATORS	50
MINIMUM ANGULAR WAVE FREQUENCY	0.10 RAD/SEC
MAXIMUM ANGULAR WAVE FREQUENCY	3.00 RAD/SEC
APPROACH ANGLE FOR INCIDENT WAVES	135.00 DEG

ANGULAR FREQUENCY (RAD/SEC)	WAVE NUMBER (RAD/FT)	ANGULAR FREQUENCY (RAD/SEC)	WAVE NUMBER (RAD/FT)
0.1000000	0.0022822	0.1591837	0.0036503
0.2183674	0.0050428	0.2775510	0.0064696
0.3367347	0.0079414	0.3959184	0.0094701
0.4551020	0.0110689	0.5142857	0.0127526
0.5734693	0.0145379	0.6326530	0.0164437
0.6918367	0.0184911	0.7510203	0.0207032
0.8102040	0.0231044	0.8693876	0.0257197
0.9285713	0.0285727	0.9877549	0.0316838
1.0469387	0.0350677	1.1061224	0.0387323
1.1653061	0.0426784	1.2244898	0.0469005
1.2836735	0.0513896	1.3428572	0.0561352
1.4020410	0.0611268	1.4612247	0.0663561
1.5204084	0.0718161	1.5795921	0.0775021
1.6387758	0.0834108	1.6979595	0.0895401
1.7571433	0.0958887	1.8163270	0.1024557
1.8755107	0.1092408	1.9346944	0.1162437
1.9938781	0.1234644	2.0530617	0.1309026
2.1122453	0.1385584	2.1714289	0.1464318
2.2306125	0.1545227	2.2897961	0.1628312
2.3489797	0.1713573	2.4081633	0.1801009
2.4673469	0.1890621	2.5265305	0.1982409
2.5857141	0.2076372	2.6448977	0.2172510
2.7040813	0.2270825	2.7632649	0.2371314
2.8224485	0.2473980	2.8816321	0.2578821
2.9408157	0.2685837	2.9999993	0.2795030

Example Problem One Output File, RELMO.OUT. (Continued)

```
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RELMO EXAMPLE PROBLEM ONE

INPUT DATA FOR SHIP  1, CALLAGHAN
COMPUTED LENGTH OF SHIP                       660.0       FT
DISTANCE BETWEEN CG AN CB                     25.53       FT
DISTANCE BETWEEN CG AND STERN                 268.8       FT
DISTANCE BETWEEN CG AND WATER PLANE           17.38       FT
TRANSVERSE METACENTRIC HEIGHT                 7.400       FT
PITCH RADIUS OF GYRATION                      173.6       FT
YAW RADIUS OF GYRATION                        173.6       FT
ROLL DAMPING COEFFICENT                      0.6000E-01
NATURAL ROLL PERIOD                           14.88       SEC
INPUT DISPLACEMENT                           0.3580E+08 LB
COMPUTED DISPLACEMENT                        0.3374E+08 LB
SURGE MOORING SPRING CONSTANT                0.0000E+00 LB/FT

TRANSVERSE SECTION DATA FOR 20 SHIP SECTIONS
```

SECTION NUMBER	BEAM (FT)	DRAFT (FT)	LENGTH (FT)	SECTION COEFFICIENT	VERTICAL CB (FT)
1	27.30	1.70	33.00	0.808	0.900
2	39.40	4.80	33.00	0.647	2.400
3	58.70	11.40	33.00	0.556	5.700
4	69.80	18.10	33.00	0.553	9.100
5	77.10	21.70	33.00	0.610	10.900
6	82.40	22.20	33.00	0.694	11.100
7	86.50	21.70	33.00	0.768	10.900
8	88.90	20.80	33.00	0.853	10.400
9	89.80	20.00	33.00	0.910	10.000
10	89.90	19.20	33.00	0.920	9.600
11	88.60	18.40	33.00	0.907	9.200
12	84.10	17.60	33.00	0.865	8.800
13	76.30	16.80	33.00	0.817	8.400
14	65.50	15.90	33.00	0.769	8.000
15	52.20	15.10	33.00	0.727	7.600
16	38.30	14.30	33.00	0.698	7.200
17	25.70	13.50	33.00	0.708	6.800
18	14.50	12.70	33.00	0.900	6.400
19	9.60	11.90	33.00	1.048	6.000
20	10.60	11.10	33.00	1.025	5.600

```
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RELMO EXAMPLE PROBLEM ONE

INPUT DATA FOR SHIP  2, 9X15
COMPUTED LENGTH OF SHIP                      90.00      FT
DISTANCE BETWEEN CG AN CB                    1.830      FT
DISTANCE BETWEEN CG AND STERN                45.00      FT
DISTANCE BETWEEN CG AND WATER PLANE          1.170      FT
TRANSVERSE METACENTRIC HEIGHT                292.0      FT
PITCH RADIUS OF GYRATION                     22.50      FT
YAW RADIUS OF GYRATION                       22.50      FT
ROLL DAMPING COEFFICENT                     0.8000E-01
NATURAL ROLL PERIOD                          1.600      SEC
INPUT DISPLACEMENT                          0.4080E+06 LB
COMPUTED DISPLACEMENT                       0.4826E+06 LB
SURGE MOORING SPRING CONSTANT               0.0000E+00 LB/FT

TRANSVERSE SECTION DATA FOR  1 SHIP SECTIONS
```

SECTION NUMBER	BEAM (FT)	DRAFT (FT)	LENGTH (FT)	SECTION COEFFICIENT	VERTICAL CB (FT)
1	63.00	1.33	90.00	1.000	0.670

Example Problem One Output File, RELMO.OUT. (Continued)

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RELMO EXAMPLE PROBLEM ONE

DYNAMIC RESPONSE OPERATORS FOR SHIP 1, CALLAGHAN

WAVE PERIOD (SEC)	WAVE LENGTH (FT)	SURGE (FT/FT)	SWAY (FT/FT)	HEAVE (FT/FT)	ROLL (RAD/FT)	PITCH (RAD/FT)	YAW (RAD/FT)
62.832	2753.162	5.01058	4.90865	0.97873	0.00148	0.00162	0.00618
39.471	1721.277	3.00479	2.94887	0.94320	0.00266	0.00253	0.00530
28.773	1245.968	2.04563	2.02131	0.88945	0.00443	0.00338	0.00486
22.638	971.184	1.46627	1.46970	0.81735	0.00752	0.00413	0.00453
18.659	791.189	1.06972	1.10404	0.72739	0.01424	0.00476	0.00424
15.870	663.473	0.77789	0.86681	0.62079	0.03751	0.00522	0.00424
13.806	567.642	0.55460	0.57326	0.49986	0.03589	0.00547	0.00337
12.217	492.699	0.38167	0.42434	0.36867	0.01543	0.00546	0.00267
10.956	432.193	0.24984	0.32426	0.23462	0.00874	0.00513	0.00213
9.931	382.102	0.15434	0.25877	0.11495	0.00529	0.00445	0.00159
9.082	339.794	0.09206	0.21339	0.08228	0.00336	0.00338	0.00108
8.366	303.489	0.05918	0.17096	0.14552	0.00260	0.00202	0.00072
7.755	271.948	0.04912	0.12360	0.19006	0.00241	0.00063	0.00067
7.227	244.295	0.05104	0.07482	0.19050	0.00212	0.00103	0.00080
6.767	219.901	0.05206	0.03318	0.14726	0.00158	0.00184	0.00084
6.361	198.309	0.04349	0.00536	0.08014	0.00095	0.00194	0.00069
6.001	179.173	0.02654	0.00751	0.03130	0.00042	0.00138	0.00039
5.680	162.221	0.00995	0.00948	0.04076	0.00011	0.00057	0.00005
5.392	147.222	0.00379	0.00807	0.03882	0.00005	0.00013	0.00016
5.131	133.968	0.01073	0.00810	0.01754	0.00012	0.00035	0.00019
4.895	122.265	0.01192	0.00723	0.01040	0.00015	0.00026	0.00006
4.679	111.930	0.00483	0.00478	0.01686	0.00012	0.00003	0.00008
4.481	102.789	0.00432	0.00308	0.00881	0.00005	0.00014	0.00012
4.300	94.689	0.00635	0.00230	0.00400	0.00003	0.00013	0.00006
4.133	87.490	0.00113	0.00111	0.00663	0.00003	0.00002	0.00003
3.978	81.071	0.00405	0.00027	0.00939	0.00001	0.00008	0.00004
3.834	75.328	0.00384	0.00005	0.00535	0.00001	0.00009	0.00003
3.700	70.172	0.00174	0.00029	0.00861	0.00001	0.00003	0.00003
3.576	65.526	0.00360	0.00020	0.00178	0.00001	0.00009	0.00002
3.459	61.326	0.00140	0.00010	0.00578	0.00001	0.00002	0.00002
3.350	57.517	0.00193	0.00009	0.00214	0.00001	0.00005	0.00002
3.248	54.052	0.00100	0.00013	0.00515	0.00000	0.00003	0.00002
3.151	50.891	0.00103	0.00013	0.00152	0.00001	0.00002	0.00002
3.060	47.999	0.00065	0.00004	0.00105	0.00001	0.00001	0.00002
2.975	45.347	0.00087	0.00005	0.00026	0.00001	0.00000	0.00001
2.894	42.909	0.00078	0.00008	0.00048	0.00000	0.00000	0.00001
2.817	40.662	0.00048	0.00008	0.00027	0.00000	0.00001	0.00001

RELATIVE MOTION BETWEEN SHIPS IN RANDOM SEAS PAGE 5
CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA

RELMO EXAMPLE PROBLEM ONE

DYNAMIC RESPONSE OPERATORS FOR SHIP 1, CALLAGHAN

WAVE PERIOD (SEC)	WAVE LENGTH (FT)	SURGE (FT/FT)	SWAY (FT/FT)	HEAVE (FT/FT)	ROLL (RAD/FT)	PITCH (RAD/FT)	YAW (RAD/FT)
2.744	38.587	0.00079	0.00007	0.00116	0.00000	0.00000	0.00001
2.675	36.667	0.00023	0.00006	0.00088	0.00000	0.00001	0.00001
2.609	34.887	0.00092	0.00008	0.00120	0.00000	0.00001	0.00001
2.547	33.233	0.00074	0.00006	0.00131	0.00000	0.00002	0.00000
2.487	31.695	0.00067	0.00010	0.00115	0.00000	0.00001	0.00001
2.430	30.260	0.00064	0.00014	0.00095	0.00000	0.00001	0.00000
2.376	28.921	0.00061	0.00018	0.00058	0.00000	0.00001	0.00000
2.324	27.669	0.00064	0.00005	0.00026	0.00000	0.00000	0.00001
2.274	26.497	0.00080	0.00024	0.00054	0.00001	0.00000	0.00001
2.226	25.397	0.00059	0.00026	0.00016	0.00000	0.00000	0.00001
2.180	24.365	0.00010	0.00014	0.00001	0.00000	0.00000	0.00000
2.137	23.394	0.00002	0.00006	0.00000	0.00000	0.00000	0.00000
2.094	22.480	0.00010	0.00006	0.00006	0.00000	0.00000	0.00000

Example Problem One Output File, RELMO.OUT. (Continued)

RELATIVE MOTION BETWEEN SHIPS IN RANDOM SEAS PAGE 6
CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA

RELMO EXAMPLE PROBLEM ONE

DYNAMIC RESPONSE OPERATORS FOR SHIP 2, 9X15

WAVE PERIOD (SEC)	WAVE LENGTH (FT)	SURGE (FT/FT)	SWAY (FT/FT)	HEAVE (FT/FT)	ROLL (RAD/FT)	PITCH (RAD/FT)	YAW (RAD/FT)
62.832	2753.162	5.18770	5.05775	0.99917	0.00156	0.00162	0.01060
39.471	1721.277	3.26616	3.14506	0.99771	0.00244	0.00259	0.01048
28.773	1245.968	2.38844	2.27566	0.99544	0.00330	0.00357	0.01039
22.638	971.184	1.88667	1.78167	0.99224	0.00413	0.00457	0.01032
18.659	791.189	1.56251	1.46467	0.98797	0.00493	0.00559	0.01027
15.870	663.473	1.33616	1.24478	0.98236	0.00570	0.00663	0.01023
13.806	567.642	1.16931	1.08358	0.97500	0.00645	0.00771	0.01021
12.217	492.699	1.04124	0.96017	0.96528	0.00716	0.00881	0.01019
10.956	432.193	0.93973	0.86213	0.95245	0.00783	0.00993	0.01017
9.931	382.102	0.85701	0.78145	0.93596	0.00845	0.01108	0.01014
9.082	339.794	0.78785	0.71264	0.91571	0.00900	0.01225	0.01008
8.366	303.489	0.72846	0.65166	0.89196	0.00946	0.01343	0.00998
7.755	271.948	0.67593	0.59537	0.86472	0.00982	0.01464	0.00979
7.227	244.295	0.62783	0.54122	0.83354	0.01003	0.01586	0.00950
6.767	219.901	0.58212	0.48718	0.79759	0.01008	0.01706	0.00907
6.361	198.309	0.53710	0.43172	0.75588	0.00991	0.01820	0.00845
6.001	179.173	0.49154	0.37396	0.70734	0.00951	0.01920	0.00764
5.680	162.221	0.44482	0.31392	0.65118	0.00885	0.02000	0.00666
5.392	147.222	0.39688	0.25275	0.58787	0.00794	0.02052	0.00563
5.131	133.968	0.34791	0.19294	0.52022	0.00681	0.02072	0.00485
4.895	122.265	0.29822	0.13866	0.45174	0.00552	0.02063	0.00479
4.679	111.930	0.24845	0.09651	0.38384	0.00414	0.02022	0.00563
4.481	102.789	0.19958	0.07474	0.31679	0.00279	0.01944	0.00697
4.300	94.689	0.15286	0.07284	0.25150	0.00158	0.01827	0.00833
4.133	87.490	0.10960	0.07607	0.18958	0.00072	0.01673	0.00939
3.978	81.071	0.07110	0.07285	0.13291	0.00059	0.01486	0.00991
3.834	75.328	0.03854	0.05977	0.08331	0.00075	0.01274	0.00979
3.700	70.172	0.01311	0.03813	0.04226	0.00065	0.01047	0.00903
3.576	65.526	0.00724	0.01175	0.01071	0.00025	0.00819	0.00775
3.459	61.326	0.01658	0.01434	0.01106	0.00036	0.00601	0.00612
3.350	57.517	0.02157	0.03496	0.02314	0.00102	0.00402	0.00435
3.248	54.052	0.02307	0.04591	0.02586	0.00153	0.00234	0.00270
3.151	50.891	0.01833	0.04475	0.02202	0.00168	0.00111	0.00134
3.060	47.999	0.01084	0.03147	0.01378	0.00132	0.00035	0.00043
2.975	45.347	0.00254	0.00858	0.00338	0.00040	0.00002	0.00003
2.894	42.909	0.00491	0.01913	0.00681	0.00099	0.00007	0.00010
2.817	40.662	0.01017	0.04548	0.01473	0.00258	0.00041	0.00055

Example Problem One Output File, RELMO.OUT. (Continued)

RELATIVE MOTION BETWEEN SHIPS IN RANDOM SEAS PAGE 7
CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA

RELMO EXAMPLE PROBLEM ONE

DYNAMIC RESPONSE OPERATORS FOR SHIP 2, 9X15

WAVE PERIOD (SEC)	WAVE LENGTH (FT)	SURGE (FT/FT)	SWAY (FT/FT)	HEAVE (FT/FT)	ROLL (RAD/FT)	PITCH (RAD/FT)	YAW (RAD/FT)
2.744	38.587	0.01241	0.06403	0.01895	0.00398	0.00090	0.00121
2.675	36.667	0.01142	0.06950	0.01886	0.00471	0.00140	0.00191
2.609	34.887	0.00765	0.05907	0.01475	0.00436	0.00180	0.00247
2.547	33.233	0.00206	0.03336	0.00768	0.00267	0.00199	0.00275
2.487	31.695	0.00408	0.00334	0.00071	0.00029	0.00194	0.00268
2.430	30.260	0.00942	0.04370	0.00860	0.00407	0.00166	0.00229
2.376	28.921	0.01289	0.07888	0.01439	0.00790	0.00120	0.00167
2.324	27.669	0.01392	0.10070	0.01706	0.01080	0.00068	0.00095
2.274	26.497	0.01254	0.10405	0.01638	0.01193	0.00021	0.00029
2.226	25.397	0.00942	0.08873	0.01300	0.01085	0.00013	0.00018
2.180	24.365	0.00559	0.06006	0.00821	0.00782	0.00027	0.00038
2.137	23.394	0.00222	0.02784	0.00356	0.00385	0.00023	0.00032
2.094	22.480	0.00022	0.00348	0.00042	0.00051	0.00005	0.00007

RELATIVE MOTION BETWEEN SHIPS IN RANDOM SEAS PAGE 8
CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA

RELMO EXAMPLE PROBLEM ONE

POSITION OF SHIP TWO WITH RESPECT TO SHIP ONE
LONGITUDINAL DISTANCE SEPARATING STERNS -150.80 FT AHEAD
TRANSVERSE DISTANCE SEPERATING CENTERS OF GRAVITY 0.00 FT RIGHT

COORDINATES FOR POINTS OF INTEREST

	LONGITUDINAL (FT)	TRANSVERSE (FT)	VERTICAL (FT)
SHIP ONE	-34.80	0.00	-6.48
SHIP TWO	90.00	0.00	2.50

RELATIVE MOTION OPERATORS FOR SHIP TWO WITH RESPECT TO SHIP ONE

WAVE PERIOD (SEC)	WAVE LENGTH (FT)	DISPLACEMENT (FT/FT)			VELOCITY (FT/SEC/FT)			ACCELERATION (G/FT)		
		LONG	TRAN	VERT	LONG	TRAN	VERT	LONG	TRAN	VERT
62.83	2753.2	3.27	1.19	0.14	0.33	0.12	0.01	0.00	0.00	0.00
39.47	1721.3	3.13	1.03	0.35	0.50	0.16	0.06	0.00	0.00	0.00
28.77	1246.0	2.94	1.24	0.63	0.64	0.27	0.14	0.00	0.00	0.00
22.64	971.2	2.69	1.52	0.97	0.75	0.42	0.27	0.01	0.00	0.00
18.66	791.2	2.40	1.81	1.35	0.81	0.61	0.45	0.01	0.01	0.00
15.87	663.5	2.08	2.13	1.73	0.82	0.85	0.69	0.01	0.01	0.01
13.81	567.6	1.74	1.60	2.08	0.79	0.73	0.95	0.01	0.01	0.01
12.22	492.7	1.41	1.74	2.34	0.72	0.89	1.21	0.01	0.01	0.02
10.96	432.2	1.11	1.71	2.47	0.64	0.98	1.42	0.01	0.02	0.03
9.93	382.1	0.88	1.56	2.41	0.56	0.99	1.52	0.01	0.02	0.03
9.08	339.8	0.73	1.32	2.13	0.50	0.91	1.48	0.01	0.02	0.03
8.37	303.5	0.64	1.06	1.68	0.48	0.80	1.26	0.01	0.02	0.03
7.76	271.9	0.59	0.89	1.21	0.48	0.72	0.98	0.01	0.02	0.02
7.23	244.3	0.54	0.81	1.08	0.47	0.70	0.94	0.01	0.02	0.03
6.77	219.9	0.51	0.67	1.34	0.47	0.62	1.25	0.01	0.02	0.04
6.36	198.3	0.48	0.44	1.56	0.48	0.43	1.54	0.01	0.01	0.05
6.00	179.2	0.45	0.39	1.50	0.47	0.41	1.57	0.02	0.01	0.05
5.68	162.2	0.40	0.44	1.24	0.44	0.48	1.37	0.02	0.02	0.05
5.39	147.2	0.34	0.33	1.09	0.40	0.38	1.27	0.01	0.01	0.05
5.13	134.0	0.29	0.34	1.12	0.36	0.42	1.38	0.01	0.02	0.05
4.89	122.3	0.25	0.34	1.10	0.32	0.43	1.41	0.01	0.02	0.06
4.68	111.9	0.20	0.33	0.99	0.27	0.44	1.33	0.01	0.02	0.06
4.48	102.8	0.15	0.38	0.96	0.21	0.53	1.35	0.01	0.02	0.06
4.30	94.7	0.11	0.37	0.90	0.16	0.54	1.31	0.01	0.02	0.06
4.13	87.5	0.07	0.43	0.79	0.10	0.65	1.20	0.00	0.03	0.06

Example Problem One Output File, RELMO.OUT. (Continued)

RELATIVE MOTION BETWEEN SHIPS IN RANDOM SEAS PAGE 9
CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA

RELMO EXAMPLE PROBLEM ONE

RELATIVE MOTION OPERATORS FOR SHIP TWO WITH RESPECT TO SHIP ONE

WAVE PERIOD (SEC)	WAVE LENGTH (FT)	DISPLACEMENT (FT/FT)			VELOCITY (FT/SEC/FT)			ACCELERATION (G/FT)		
		LONG	TRAN	VERT	LONG	TRAN	VERT	LONG	TRAN	VERT
3.98	81.1	0.04	0.42	0.71	0.06	0.67	1.11	0.00	0.03	0.05
3.83	75.3	0.00	0.43	0.57	0.01	0.71	0.93	0.00	0.04	0.05
3.70	70.2	0.01	0.39	0.48	0.02	0.66	0.81	0.00	0.03	0.04
3.58	65.5	0.03	0.35	0.34	0.05	0.61	0.61	0.00	0.03	0.03
3.46	61.3	0.03	0.28	0.27	0.05	0.51	0.49	0.00	0.03	0.03
4.13	87.5	0.07	0.43	0.79	0.10	0.65	1.20	0.00	0.03	0.06
3.98	81.1	0.04	0.42	0.71	0.06	0.67	1.11	0.00	0.03	0.05
3.83	75.3	0.00	0.43	0.57	0.01	0.71	0.93	0.00	0.04	0.05
3.70	70.2	0.01	0.39	0.48	0.02	0.66	0.81	0.00	0.03	0.04
3.58	65.5	0.03	0.35	0.34	0.05	0.61	0.61	0.00	0.03	0.03
3.46	61.3	0.03	0.28	0.27	0.05	0.51	0.49	0.00	0.03	0.03
3.35	57.5	0.03	0.22	0.17	0.06	0.40	0.32	0.00	0.02	0.02
3.25	54.1	0.03	0.15	0.10	0.06	0.29	0.18	0.00	0.02	0.01
3.15	50.9	0.02	0.09	0.05	0.04	0.18	0.10	0.00	0.01	0.01
3.06	48.0	0.01	0.05	0.02	0.03	0.10	0.05	0.00	0.01	0.00
2.97	45.3	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00
2.89	42.9	0.01	0.02	0.01	0.01	0.04	0.02	0.00	0.00	0.00
2.82	40.7	0.01	0.04	0.03	0.02	0.08	0.06	0.00	0.01	0.00
2.74	38.6	0.01	0.06	0.05	0.02	0.13	0.11	0.00	0.01	0.01
2.67	36.7	0.01	0.07	0.06	0.02	0.17	0.15	0.00	0.01	0.01
2.61	34.9	0.00	0.09	0.08	0.01	0.21	0.19	0.00	0.02	0.01
2.55	33.2	0.00	0.11	0.09	0.01	0.26	0.22	0.00	0.02	0.02
2.49	31.7	0.01	0.12	0.09	0.02	0.31	0.23	0.00	0.02	0.02
2.43	30.3	0.01	0.14	0.08	0.03	0.36	0.20	0.00	0.03	0.02
2.38	28.9	0.02	0.15	0.06	0.04	0.38	0.15	0.00	0.03	0.01
2.32	27.7	0.02	0.14	0.04	0.04	0.38	0.10	0.00	0.03	0.01
2.27	26.5	0.01	0.13	0.02	0.04	0.35	0.05	0.00	0.03	0.00
2.23	25.4	0.01	0.09	0.01	0.03	0.27	0.04	0.00	0.02	0.00
2.18	24.4	0.01	0.06	0.01	0.01	0.16	0.04	0.00	0.01	0.00
2.14	23.4	0.00	0.02	0.01	0.00	0.06	0.03	0.00	0.01	0.00
2.09	22.5	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00

RELMO EXAMPLE PROBLEM ONE

THE FOLLOWING STATISTICAL INFORMATION IS BASED ON THE PIERSON-MOSKOWITZ SPECTRUM. IT HAS BEEN MODIFIED SLIGHTLY IN ORDER TO ACCOUNT FOR THE FINITE DEPTH OF WATER.

RELATIVE MOTION

SIGNIFICANT WAVE HEIGHT (FT)	WAVE AMPLI. (FT)	DISPLACEMENT (FT) LONG	TRAN	VERT	VELOCITY (FT/SEC) LONG	TRAN	VERT	ACCELERATION (G) LONG	TRAN	VERT
2.00	0.9	0.09	0.27	0.53	0.12	0.44	0.76	0.01	0.02	0.04
3.00	1.5	0.30	0.49	1.21	0.35	0.70	1.56	0.01	0.03	0.07
5.00	2.4	0.86	1.16	2.68	0.86	1.25	2.95	0.03	0.05	0.11
7.00	3.3	1.56	2.30	4.36	1.37	2.00	4.16	0.04	0.06	0.14
10.00	4.7	3.00	4.66	7.67	2.21	3.38	6.07	0.06	0.09	0.17

SHIP MOTION

SIGNIFICANT WAVE HEIGHT	WAVE AMPLI.	SHIP	DISPLACEMENT (FT) SURGE	SWAY	HEAVE	ROTATION (RAD) ROLL	PITCH	YAW
2.00	0.9	1	0.004	0.002	0.008	0.000	0.000	0.000
		2	0.114	0.071	0.176	0.003	0.011	0.006
3.00	1.5	1	0.015	0.010	0.037	0.000	0.001	0.000
		2	0.346	0.228	0.514	0.007	0.022	0.010
5.00	2.4	1	0.068	0.101	0.190	0.002	0.002	0.001
		2	0.980	0.765	1.367	0.017	0.041	0.018
7.00	3.3	1	0.163	0.301	0.361	0.006	0.005	0.002
		2	1.735	1.453	2.282	0.027	0.055	0.027
10.00	4.7	1	0.498	0.765	0.653	0.019	0.012	0.005
		2	3.052	2.678	3.692	0.040	0.072	0.042

Example Problem One RAO Output File, RELMO.RAO for Ship One Only.

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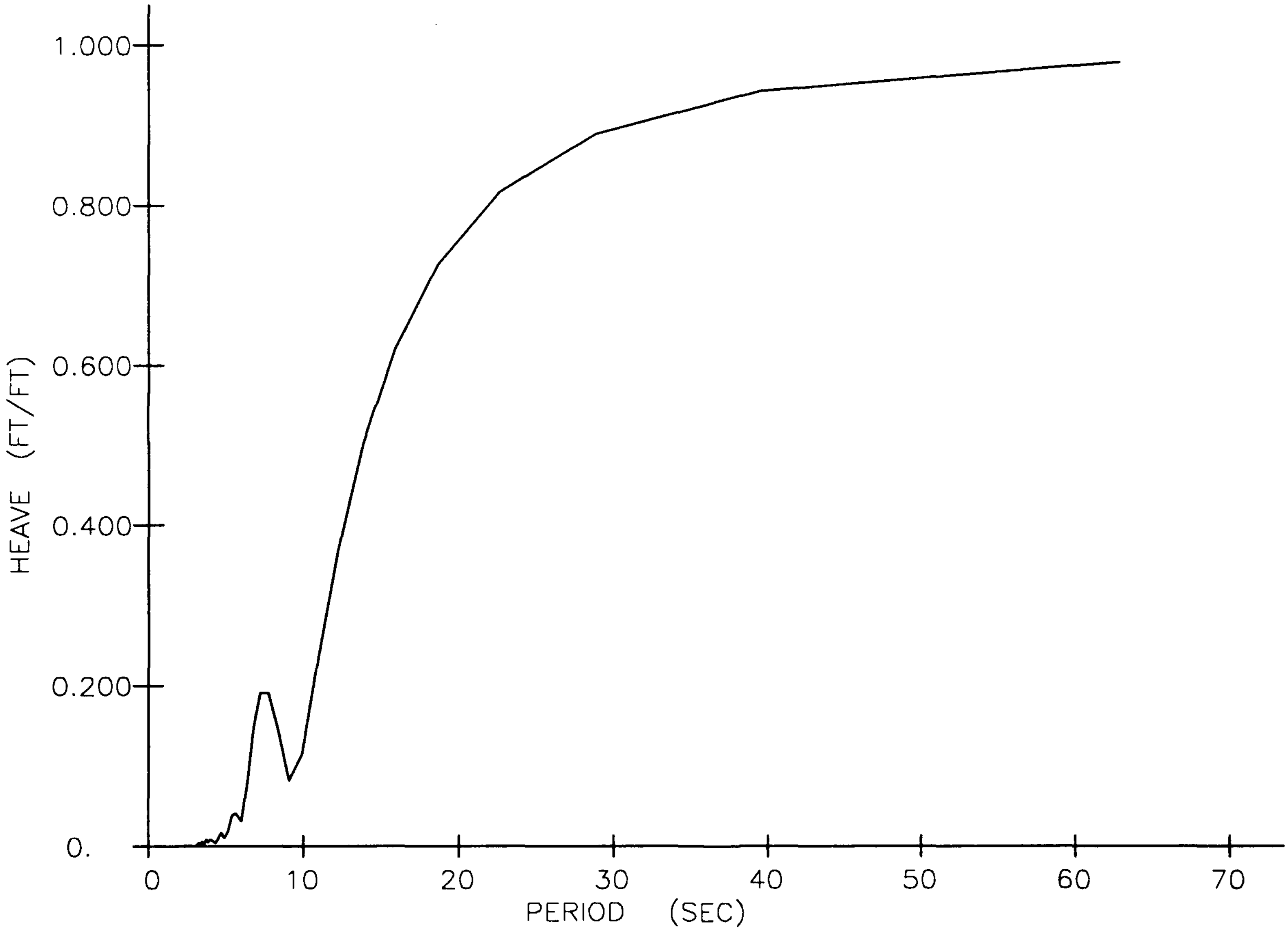
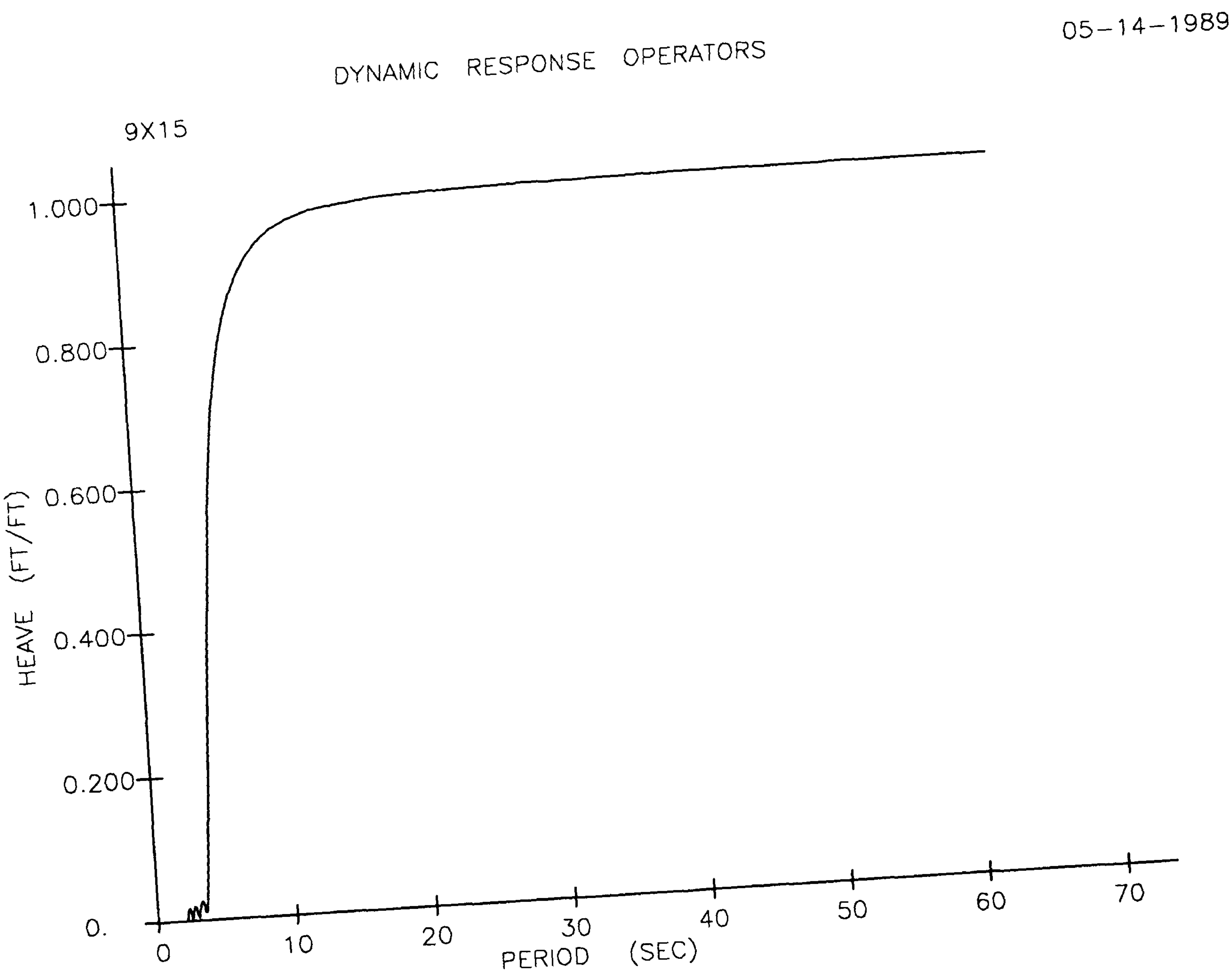
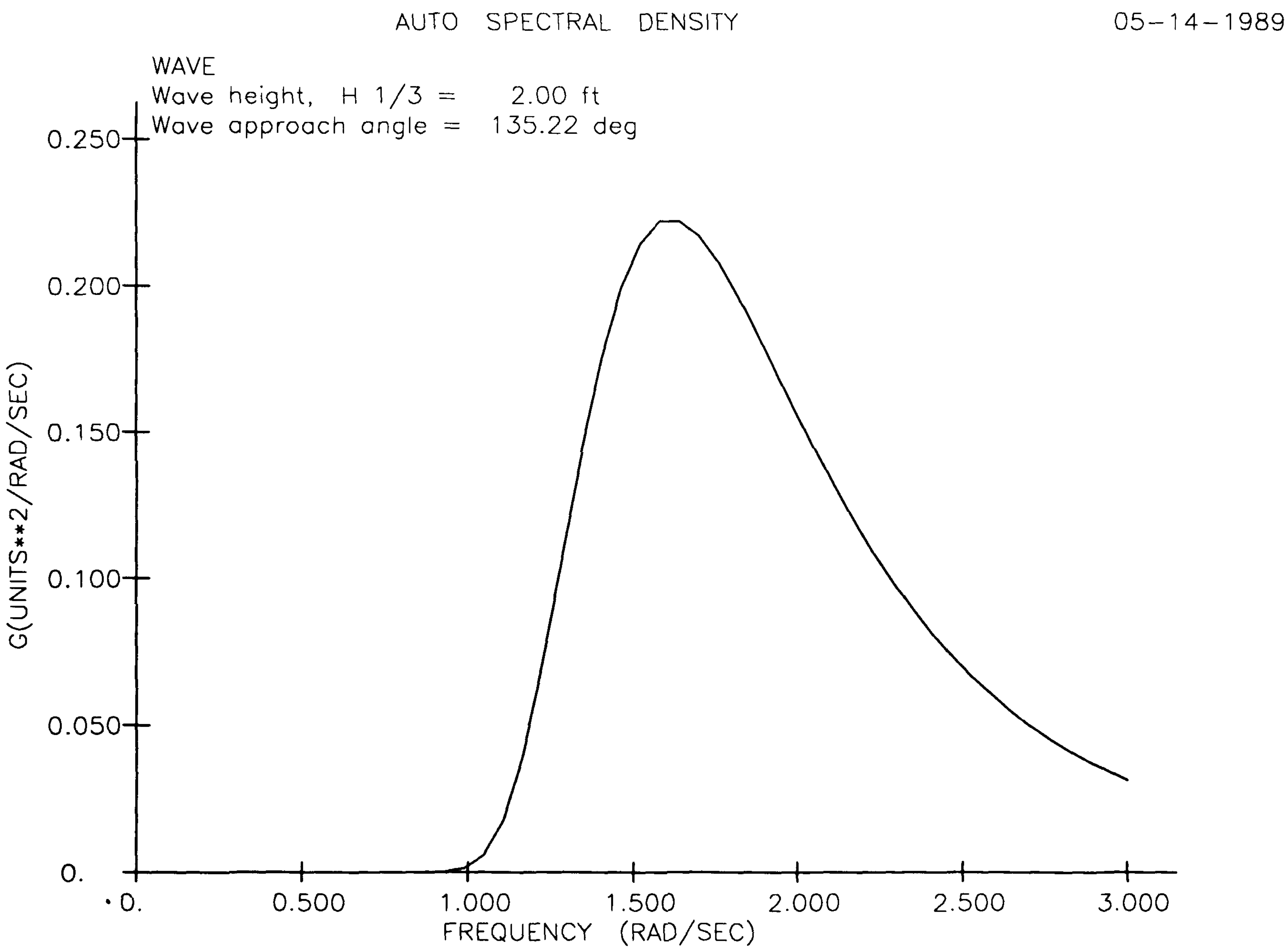
0.100	0.002	5.011	4.909	0.979	0.001	0.002	0.006	-1.619	1.526	0.005	1.770	1.518	0.540
0.159	0.004	3.005	2.949	0.943	0.003	0.003	0.005	-1.645	1.501	0.013	1.874	1.488	0.263
0.218	0.005	2.046	2.021	0.889	0.004	0.003	0.005	-1.671	1.478	0.026	1.960	1.459	0.076
0.278	0.006	1.466	1.470	0.817	0.008	0.004	0.005	-1.695	1.460	0.046	2.035	1.432	-0.073
0.337	0.008	1.070	1.104	0.727	0.014	0.005	0.004	-1.717	1.451	0.075	2.141	1.407	-0.208
0.396	0.009	0.778	0.867	0.621	0.038	0.005	0.004	-1.735	1.488	0.119	2.566	1.385	-0.318
0.455	0.011	0.555	0.573	0.500	0.036	0.005	0.003	-1.748	1.596	0.184	-2.122	1.369	-0.201
0.514	0.013	0.382	0.424	0.369	0.015	0.005	0.003	-1.754	1.614	0.288	-1.857	1.360	-0.357
0.573	0.015	0.250	0.324	0.235	0.009	0.005	0.002	-1.751	1.720	0.474	-1.965	1.362	-0.442
0.633	0.016	0.154	0.259	0.115	0.005	0.004	0.002	-1.730	1.852	0.945	-2.252	1.373	-0.466
0.692	0.018	0.092	0.213	0.082	0.003	0.003	0.001	-1.676	1.948	2.321	-2.749	1.387	-0.377
0.751	0.021	0.059	0.171	0.146	0.003	0.002	0.001	-1.553	1.972	3.053	2.885	1.365	-0.025
0.810	0.023	0.049	0.124	0.190	0.002	0.001	0.001	-1.362	1.929	-2.954	2.363	0.891	0.523
0.869	0.026	0.051	0.075	0.191	0.002	0.001	0.001	-1.172	1.841	-2.788	2.047	-0.902	0.772
0.929	0.029	0.052	0.033	0.147	0.002	0.002	0.001	-0.987	1.729	-2.697	1.871	-0.985	0.761
0.988	0.032	0.043	0.005	0.080	0.001	0.002	0.001	-0.762	1.542	-2.769	1.794	-0.892	0.625
1.047	0.035	0.027	0.008	0.031	0.000	0.001	0.000	-0.441	-1.449	2.667	1.812	-0.780	0.421
1.106	0.039	0.010	0.009	0.041	0.000	0.001	0.000	0.129	-1.347	1.625	1.866	-0.754	0.173
1.165	0.043	0.004	0.008	0.039	0.000	0.000	0.000	2.534	-0.903	1.406	0.136	-2.652	3.009
1.224	0.047	0.011	0.008	0.018	0.000	0.000	0.000	-2.818	-0.419	1.119	0.134	3.064	2.656
1.284	0.051	0.012	0.007	0.010	0.000	0.000	0.000	-2.617	-0.154	-0.772	0.220	3.066	2.070
1.343	0.056	0.005	0.005	0.017	0.000	0.000	0.000	-2.695	0.167	-1.211	0.236	2.460	-0.911
1.402	0.061	0.004	0.003	0.009	0.000	0.000	0.000	0.606	0.776	-1.288	0.452	0.230	-1.508
1.461	0.066	0.006	0.002	0.004	0.000	0.000	0.000	0.291	1.233	1.758	1.752	0.196	-2.264
1.520	0.072	0.001	0.001	0.007	0.000	0.000	0.000	-0.747	1.479	1.547	1.714	1.673	1.513
1.580	0.078	0.004	0.000	0.009	0.000	0.000	0.000	-2.779	2.309	2.049	0.849	-2.548	0.285
1.639	0.083	0.004	0.000	0.005	0.000	0.000	0.000	2.630	2.292	-0.487	-0.871	2.896	-1.288
1.698	0.090	0.002	0.000	0.009	0.000	0.000	0.000	0.277	0.279	-1.907	2.730	0.375	-3.100
1.757	0.096	0.004	0.000	0.002	0.000	0.000	0.000	-1.062	0.147	-1.156	1.185	-0.652	1.329
1.816	0.102	0.001	0.000	0.006	0.000	0.000	0.000	-2.993	2.480	1.144	-0.687	-2.283	-0.596
1.876	0.109	0.002	0.000	0.002	0.000	0.000	0.000	1.816	2.518	-3.096	-2.331	2.613	-2.384
1.935	0.116	0.001	0.000	0.005	0.000	0.000	0.000	-1.511	-1.321	-2.414	2.048	-2.664	1.922
1.994	0.123	0.001	0.000	0.002	0.000	0.000	0.000	-2.343	-1.685	-2.893	-0.160	-1.116	-0.001
2.053	0.131	0.001	0.000	0.001	0.000	0.000	0.000	1.585	1.536	0.476	-1.941	-2.004	-2.069
2.112	0.139	0.001	0.000	0.000	0.000	0.000	0.000	-0.490	1.250	-0.943	2.343	1.340	2.304
2.171	0.146	0.001	0.000	0.000	0.000	0.000	0.000	-2.951	2.690	-2.711	0.488	1.952	0.055
2.231	0.155	0.000	0.000	0.000	0.000	0.000	0.000	1.552	2.487	-1.019	-2.315	-1.298	-1.968
2.290	0.163	0.001	0.000	0.001	0.000	0.000	0.000	-1.069	-2.665	0.354	2.436	0.467	1.806
2.349	0.171	0.000	0.000	0.001	0.000	0.000	0.000	1.900	-2.505	1.929	-0.857	1.359	-0.323
2.408	0.180	0.001	0.000	0.001	0.000	0.000	0.000	0.843	-0.470	1.889	-2.701	2.232	2.967
2.467	0.189	0.001	0.000	0.001	0.000	0.000	0.000	2.857	-0.018	-2.952	0.400	2.868	0.618
2.527	0.198	0.001	0.000	0.001	0.000	0.000	0.000	3.055	1.766	-2.036	-1.934	-1.396	-1.679
2.586	0.208	0.001	0.000	0.001	0.000	0.000	0.000	-0.883	2.938	-0.055	2.861	-0.617	1.414
2.645	0.217	0.001	0.000	0.001	0.000	0.000	0.000	0.275	-3.093	1.005	-2.826	1.547	-1.369
2.704	0.227	0.001	0.000	0.000	0.000	0.000	0.000	-0.627	-0.421	-2.899	2.050	-2.547	2.168
2.763	0.237	0.001	0.000	0.001	0.000	0.000	0.000	-2.774	-0.187	-0.816	0.255	-1.399	0.651
2.822	0.247	0.001	0.000	0.000	0.000	0.000	0.000	2.065	-0.193	-0.076	-0.540	1.107	-1.947
2.882	0.258	0.000	0.000	0.000	0.000	0.000	0.000	-2.710	-0.130	-1.362	-0.078	2.882	2.894
2.941	0.269	0.000	0.000	0.000	0.000	0.000	0.000	2.376	0.877	1.076	-0.505	1.609	-2.075
3.000	0.280	0.000	0.000	0.000	0.000	0.000	0.000	-2.146	2.386	-1.426	2.220	-2.295	-0.438

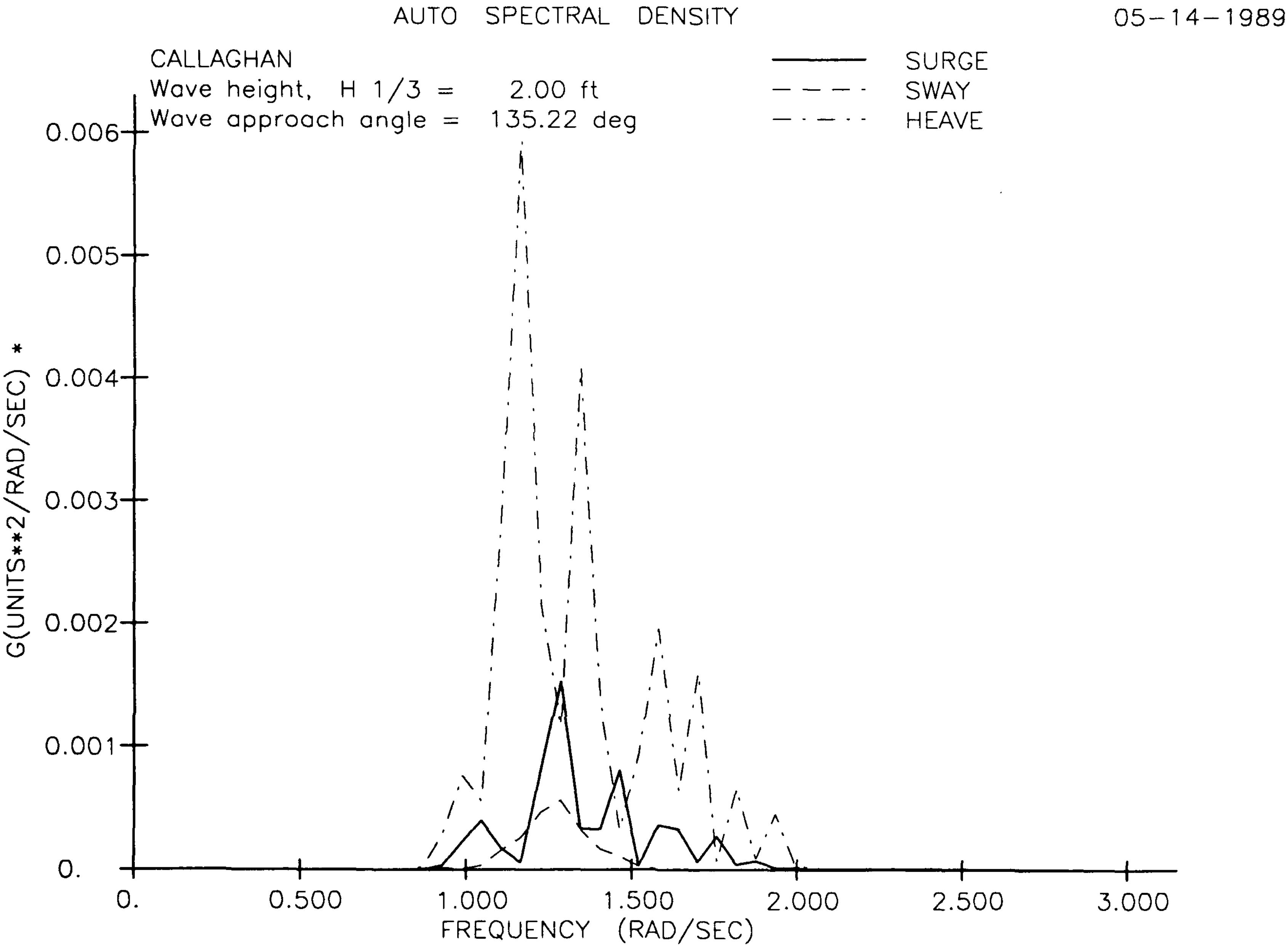
DYNAMIC RESPONSE OPERATORS 05-14-1989

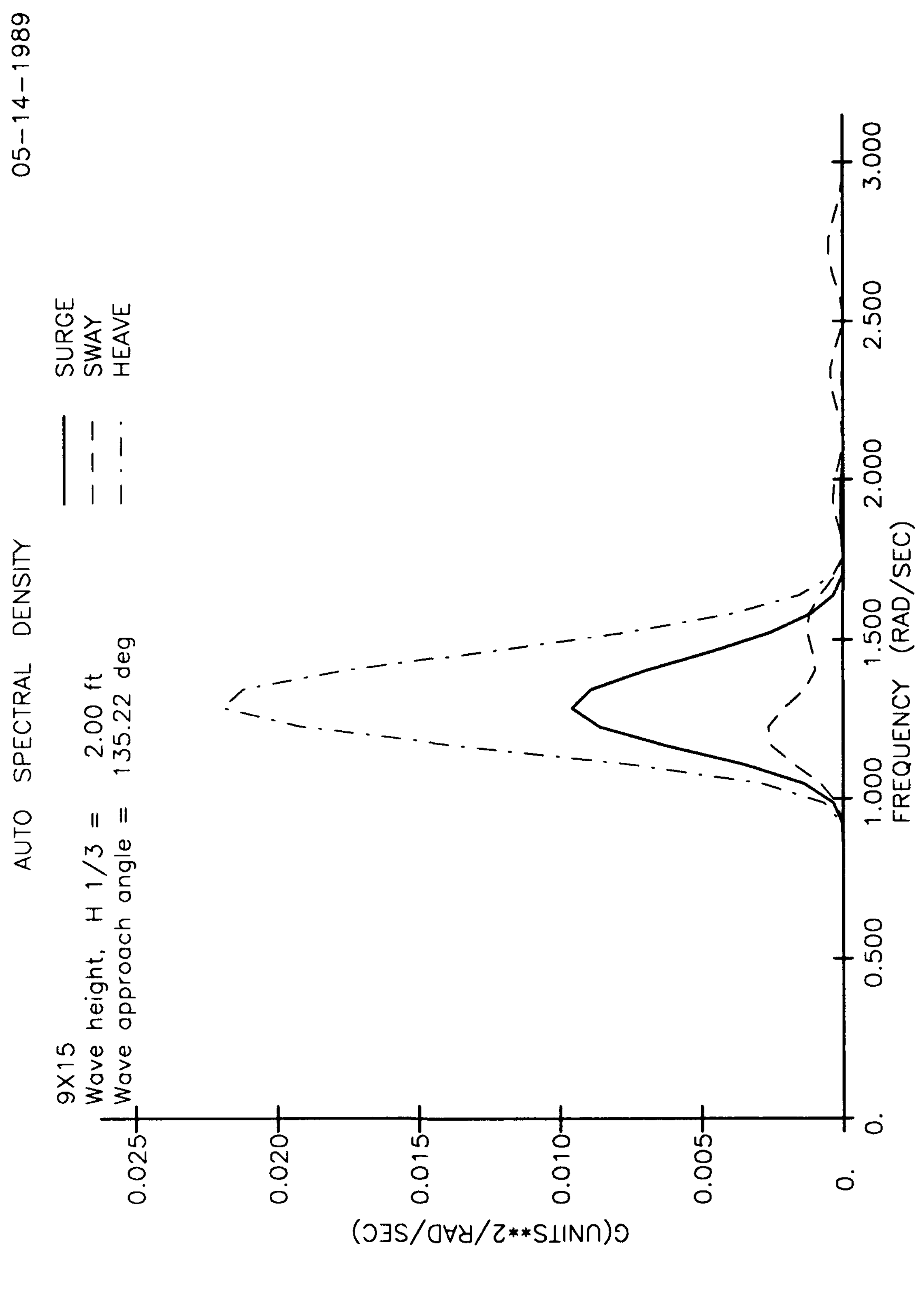
CALLAGHAN




05-14-1989
DYNAMIC RESPONSE OPERATORS
9X15
HEAVE (FT/FT)
1.000
0.800
0.600
0.400
0.200
0.
0
10
20
30
40
50
60
70
PERIOD (SEC)


AUTO SPECTRAL DENSITY
05-14-1989
WAVE
Wave height, H 1/3 = 2.00 ft
Wave approach angle = 135.22 deg
G(UNITS**2/RAD/SEC)
0.250
0.200
0.150
0.100
0.050
0.
0.
0.500
1.000
1.500
2.000
2.500
3.000
FREQUENCY (RAD/SEC)


AUTO SPECTRAL DENSITY
05-14-1989
CALLAGHAN
Wave height, H 1/3 = 2.00 ft
Wave approach angle = 135.22 deg
SURGE
SWAY
HEAVE
G(UNITS**2/RAD/SEC) *
0.006
0.005
0.004
0.003
0.002
0.001
0.
0.
0.500
1.000
1.500
2.000
2.500
3.000
FREQUENCY (RAD/SEC)


AUTO SPECTRAL DENSITY
05-14-1989
9X15
Wave height, H 1/3 = 2.00 ft
Wave approach angle = 135.22 deg
SURGE
SWAY
HEAVE
G(UNITS**2/RAD/SEC)
0.025
0.020
0.015
0.010
0.005
0.
0.
0.500
1.000
1.500
2.000
2.500
3.000
FREQUENCY (RAD/SEC)

RELMO VERSION 1.0

FEEDBACK REPORT

The Naval Civil Engineering Laboratory is fully dedicated to supporting GEMS users. A primary requirement for this task is to establish a priority listing of user requirements. It would be of great value to the development of new software if you, the user, would complete the feedback questions below. Since each individual user may have specific requirements, please reproduce this page as many times as necessary.

Please circle the number that best applies in questions 1 through 4, complete the other questions, fold at tic marks, and mail to NCEL with franked label on reverse side or to address at bottom of page.

1. Was the software beneficial (productive)?

   No benefit 0 1 2 3 4 5 6 7 8 9 10 Very beneficial

2. Was it easy to use (user friendly)?

   Difficult 0 1 2 3 4 5 6 7 8 9 10 Very easy

3. Does this software make decisions more reliable?

   No 0 1 2 3 4 5 6 7 8 9 10 Yes

4. Does it better document the design?

   No 0 1 2 3 4 5 6 7 8 9 10 Yes

5. Did it save time?

   Yes_____ No_____ Estimated percent saved_____

6. What would make future software more user friendly?

7. What further support would you like to have on the GEMS system?

8. What other comments or remarks would you like to add?

Activity____
Telephone____

Mail address is:
NAVFAC GEMS Support Group
Naval Civil Engineering Laboratory
Code L54
Port Hueneme, CA 93043-5003

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Naval Civil Engineering Laboratory
Port Hueneme, CA 93043-5003

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